ESD-TR-67-294

PROPOSED SYSTEM CONCEPT FOR REAL-TIME PROCESSING OF AUTODIN MESSAGES

May 1967

COMPUTER DIRECTORATE
ELECTRONIC SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
L. G. Hanscom Field, Bedford, Massachusetts

This document has been approved for public release and sale; its distribution is unlimited.

ESUPD

(Prepared under Contract No. AF 19(628)-67-C-0259 by COMRESS, Inc., 2120 Bladensburg Road, N.E., Washington, D. C. 20018)

LEGAL NOTICE

OTHER NOTICES

ESD-TR-67-294

PROPOSED SYSTEM CONCEPT FOR REAL-TIME PROCESSING OF AUTODIN MESSAGES

May 1967

COMPUTER DIRECTORATE
ELECTRONIC SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
L. G. Hanscom Field, Bedford, Massachusetts

(Prepared under Contract No. AF 19(628)-67-C-0259 by COMRESS, Inc., 2120 Bladensburg Road, N.E., Washington, D. C. 20018)

FOREWARD

Contractor: COMRESS, Incorporated
2120 Bladensburg Road, N. E.
Washington, D. C. 20018

Contract Number: F19(628)-67-C-0259

Air Force Program Monitor: Russell A. Meier, Major ESVPP

This report includes all elements of Phase I of the contract and all analysis and design work was performed between 23 February 1967 and 22 April 1967.

This report was submitted 2 May 1967.

This technical report has been reviewed and is approved.

Charles A. Laustrup, Colonel
Chief, Computer and Display Division, EVPD

ABSTRACT

This report is the proposed system concept for the real-time processing of AUTODIN messages at the Data Services Center, HQ, USAF. It is composed of three major elements, a description of the present system, the proposed system, and analysis and conclusions supporting the proposed system. The description of the present system highlights the principal elements of control in a manner designed to emphasize the batch processing nature of the present computer programs, and their inter-relationship with each other and with the manual RCS control system. The problems that characterize the present system are principally those of the time that elapses between receipt of a message on the AUTODIN terminal and the identification of errors that invalidate the message and require further contact with the originator to correct the errors. The manual RCS control file was identified as being one of the major elements of this time lapse because of the periodic manual transcription of incoming messages to handwritten control cards. The proposed system emphasizes the desirability of performing data edits immediately upon receipt of each message and the instantaneous transmission of an error message to the originator when the incoming message has failed a format edit. The real-time concept is also the main element of management control through the Command and Query Terminal that provides on-line management decision-making ability without sacrificing any of the advantages of the computer-controlled real-time system.

TABLE OF CONTENTS

		Page
SECTION I	INTRODUCTION	1
SECTION II	DESCRIPTION OF THE PRESENT SYSTEM	2
	A. Incoming Message Procedures	2
	B. Outgoing Message Procedures	4
SECTION III	PROPOSED SYSTEM	10
	A. Incoming Messages	10
	B. Terminal Functions	12
	C. Outgoing Messages	15
	D. Program Maintenance and System Statistics	16
	E. System Recovery Procedures	16
	F. Operating System and Software Utilization	17
	G. System Design Philosophy	18
SECTION IV	CONCLUSIONS	20
APPENDIX I	INTERNAL SYSTEM MESSAGE HEADERS	27
APPENDIX II	TABLES	29
APPENDIX III	FORMAT EDITS	34
APPENDIX IV	RCS DATA	36

LIST OF ILLUSTRATIONS

		Page
Figure 1	PRESENT SYSTEM - INCOMING MESSAGES	3
Figure 2	PRESENT SYSTEM - OUTGOING MESSAGES	5
Figure 3	STATION SERIAL NUMBER LOG	6
Figure 4	REEL LOG	8
Figure 5	AUTODIN TRAFFIC LOG	9
Figure 6	PROPOSED SYSTEM - PROCESSING OF INCOMING TRAFFIC	10
Figure 7	PROPOSED SYSTEM - TERMINAL FUNCTIONS	12
Figure 8	PROPOSED SYSTEM - PROCESSING OF OUTGOING TRAFFIC	15
Figure 9	COST PERFORMANCE CHARACTERISTICS	26
Figure 10	INTERNAL SYSTEM MESSAGE HEADERS (a and b)	27
Figure 11	RCS CORE TABLE	30
Figure 12	RCS COMMAND TABLE (DISK)	31
Figure 13	RCS COMMAND MESSAGE TABLE	32
Figure 14	TABLE FLOW	33
Table I	COMMAND AND QUERY TERMINAL FUNCTIONS	13

LIST OF ABBREVIATIONS AND SYMBOLS

ACQT	AUTODIN Command and Query Terminal
AFHQ O-209	card form used to manually log incoming RCS messages
BCD	binary coded decimal
BILDR	computer program that builds outgoing messages
CC	card column
CMD	Command
CRT	cathode ray tube
I/O	input/output
LMF	Language Media Format
LOGER	computer program that logs incoming messages
RCS	Report Control Symbol
RITER	computer program that extracts RCS messages
TLU	table look-up

SECTION I

INTRODUCTION

The objective of Phase I of this contract is to develop a system concept for the efficient real-time processing of AUTODIN messages for the Data Services Center, HQ, USAF.

Within the context of the operational requirements, efficient real-time processing means providing as much additional speed in editing, logging, storing and manipulating messages as the function can benefit from at a reasonable cost. In this case, the speed of the AUTODIN line (2400 baud) provides a preestablished criteria on which to build system capability. That is, there is no advantage in substituting a faster line because the present line is capable of adequately handling peak load traffic. The system can, however, benefit from improved time lapse once a message has been received. Essentially, these improvements are the placing of all format edits at the earliest possible point in the processing cycle to enable the system to identify format errors and generate error messages within seconds after receipt of the message.

The real-time element of message logging and storage in the proposed system is the immediate logging and transfer of a message to the mass random storage device following the format edits. A message is, therefore, "usable" seconds after it is received in that it is entered in a log that can be queried. At this point in the processing cycle, the man-machine interface begins. The query terminal operator can determine whether the message is available for further processing. If the message was the final message for an RCS, the Command terminal operator would have received an automatic alert from the system informing him that the RCS was complete and ready for extracting. The Command terminal operator will also receive an automatic alert for each message that fails the format edit test. He can display the headers and trailers on the terminal cathode ray tube and, if he determines that the error is correctable, he can key-in the correct entry and transfer the message to the regular storage area.

SECTION II

DESCRIPTION OF THE PRESENT SYSTEM

A. Incoming Message Procedures

The current system can be characterized as a series of batch processing runs that perform rudimentary format edits, as shown in Figure 1. One of these programs (LOGER) provides a listing of incoming messages that is manually transcribed to control cards. This manually maintained RCS control file is the hub of the present system in that the Data Services Division is totally dependent upon it for accurate, up-to-date information necessary to schedule data editing and report production runs.

Manual RCS Control Procedures

Step 1: Set up an AFHQ O-209 card for each incoming RCS. There will be a separate card for each Command that is required to submit a particular RCS. Set-up consists of recording RCS number, Command symbol, as of date, due date, classification and card number.

Step 2: Delinquency Control: Twenty-four hours after an RCS is due, a delinquency notice message (TWX, telephone, etc.) is sent to each Command that has not transmitted a complete RCS.

Step 3: Message Logging: Upon receipt of the first transmission from each Command of an RCS, the following items of information are extracted from the LOGER list and recorded on the AUTODIN Control Card.

a) Date

Mailed data only — b) 903 card shipment number, card count or reel number

c) LOGER tape reel number

d) LOGER message number

e) Control Number - in this case, "1" indicates that this is the first AUTODIN Terminal tape reel containing messages for the indicated Command and RCS.

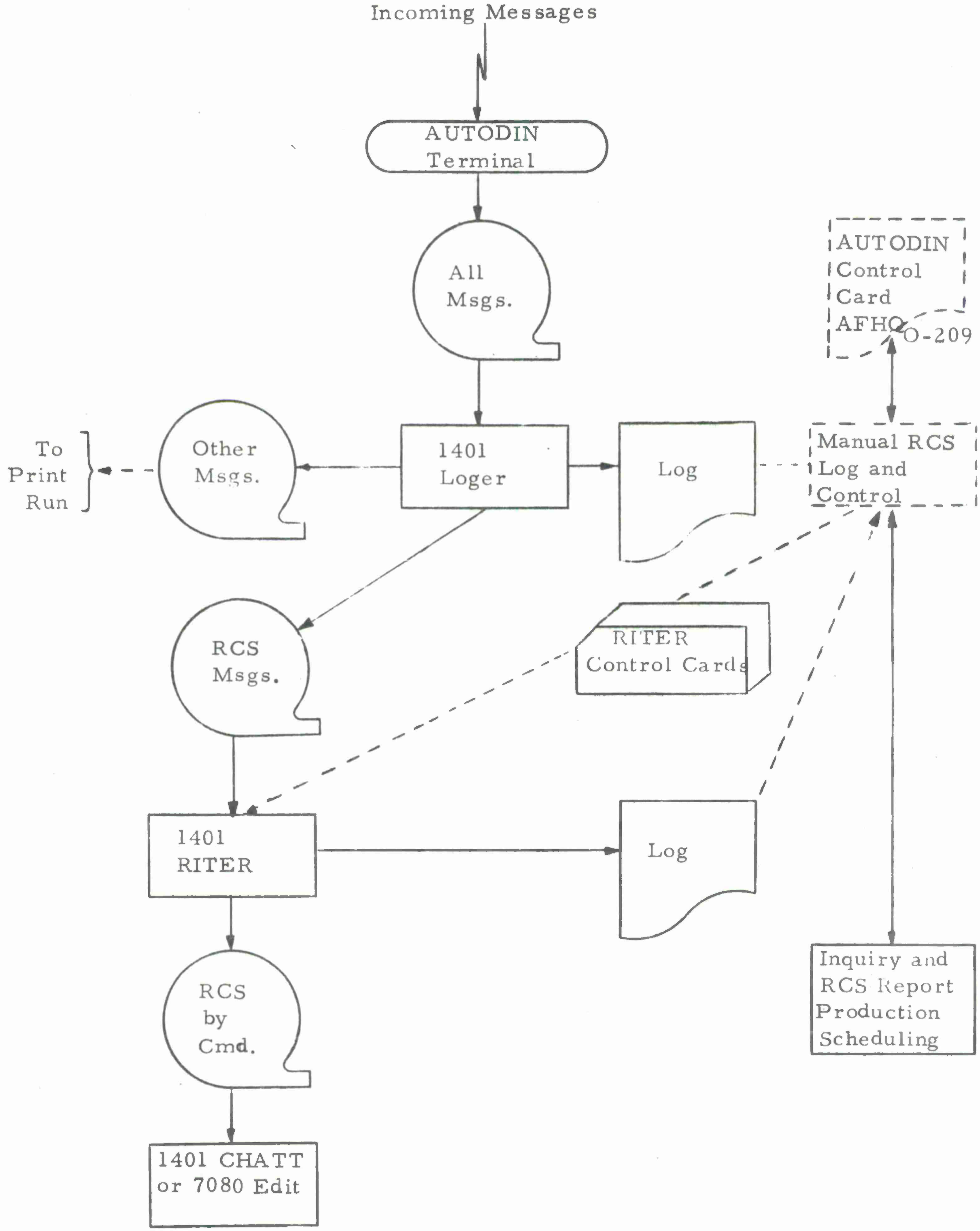


Figure 1: PRESENT SYSTEM - INCOMING MESSAGES

Step 3: Message Logging (Continued)

f) Recording of receipt of each Command Message Number is accomplished by writing the Control Number in each block representing a Command Message Number. That is, if this is Control Number 1 (first AUTODIN Tape for this Command and RCS) and Command Message Numbers 1, 6, 10 and 12 are on that tape, then a 1 is written in blocks 1, 6, 10 and 12.

g) Each message on the LOGER that is a duplicate of one already logged is crossed out. That is, the first transmission is used.

h) A Resubmission message, identified by an "R" in position 32 of the Text Header, must be substituted for the original message. There is no way of correcting the specific error field or fields, the entire "R" message is substituted.

Step 4: Format Edits: AUTODIN Header and Trailer and Text Header and Trailer are scanned for errors.

B. Outgoing Message Procedures

In the present system, as shown in Figure 2, all cards to be sent out are first put on magnetic tape. The following discussion enumerates the several steps in this process:

Step 1: The number of the requested tape to be sent out is taken to the AUTODIN Management Section. In new or one-time transmissions, the necessary information to fill out the Message Build Routine (BILDR) control cards must be provided. In recurring report, only the record count, "As of Date", and any change in addressee information must be provided since control cards are on file. The AUTODIN Standard Job Register is used for this purpose.

Step 2: The AUTODIN Management Section will then assign an arbitrary station serial number sequence according to the record count of the outgoing data. (Allow 40,000 characters per message.) The station serial number sequence, the RCS of the outgoing data and the date are then entered into the station serial number log. (See Figure 3.)

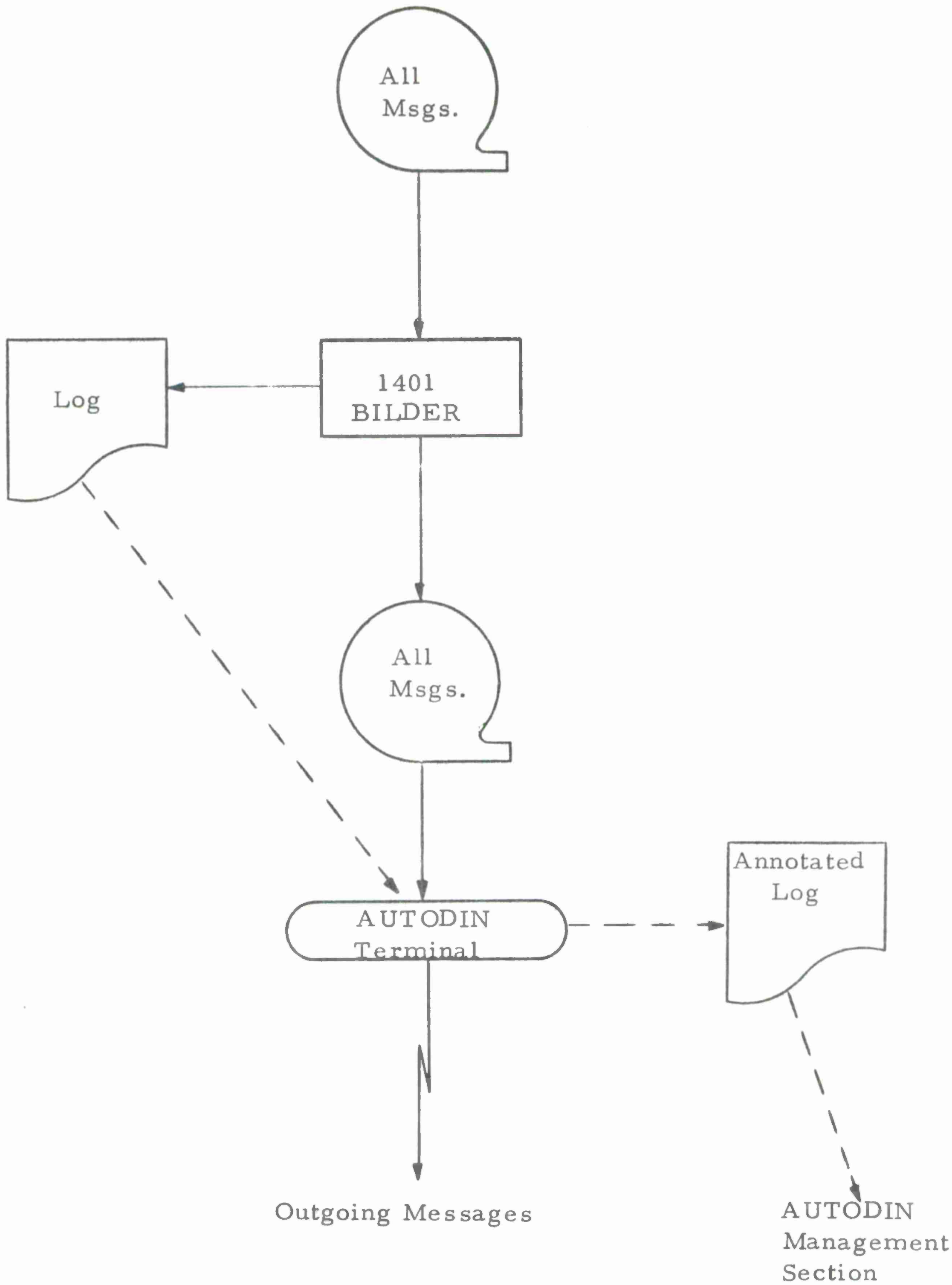


Figure 2: PRESENT SYSTEM - OUTGOING MESSAGES

STATION SERIAL NO.		RCS	DATE	REMARKS
START	STOP			
1230	1241	AR3092F	6 Feb	
1243		AF-C147	6 Feb	
1244	1262	MAP/EAM	8 Feb	

Figure 3: STATION SERIAL NUMBER LOG

B. Outgoing Message Procedures (Continued)

Step 3: The data tape number and the BILDR control cards, along with any ADP Services request forms, are sent to the operations sections.

Step 4: The BILDR Program is then run on the 1401 using the control cards and the data tape from Step 3 as input. This program uses the control cards to obtain the necessary information for the AUTODIN and Text Headers and Trailers. The builder program segments the data into one or more messages of 40,000 characters (including Header and Trailers). The output message tape number and the log from the builder program is then returned to the AUTODIN Management Section. The data reel is returned to the library.

Step 5: Upon receipt of the builder log and output tape reel number, an entry is made in the tape reel log (Figure 4). The remarks column is used to record RCS content of the tape.

Step 6: The BILDR log and tape reel are then sent to the AUTODIN terminal for transmission.

Step 7: At the AUTODIN terminal, the transmission time of each of the messages of the total data transmission is recorded and any error conditions indicated. The builder log, on which the times have been recorded, is then returned to the AUTODIN Management Section. The output reel is returned to the library.

Additional Actions

1. Daily counts are kept of the messages transmitted and retransmitted in the AUTODIN Traffic Log. (Figure 5)

2. Monthly totals of outgoing traffic are also recorded.

DATE FRCC	REEL NO.	DATE RETCC	REMARKS
20 Feb	10134	23 Feb	ADC-D12
20 Feb	10110		CSU-PD
21 Feb	16011		AU-S5
22 Feb	10234		RAC-PD (Mailed)

FRCC - From Computer Center

RETCC - Returned to Computer Center

Figure 4: REEL LOG

	IN	OUT				Feb '67
		Reg	Tran	Retran		
DATE		MSG	RC	MSG	RC	Total Record Count
1		4	1,729	1	500	
2		49	23,935	1	500	
TOTAL						

MSG - Messages

RC - Records

Reg Tran - Regular Transmission

Re-Tran - Re-Transmission

Figure 5: AUTODIN TRAFFIC LOG

SECTION III

PROPOSED SYSTEM

A. Incoming Messages

The processing and storage of incoming traffic, as shown in Figure 7, is composed of the following major functions:

1. Format Editing

2. Error Message Generation

3. Message Logging and Statistics

4. Message Storage and Retrieval

5. Automatic Alert Generation

6. Printing of Selected Messages

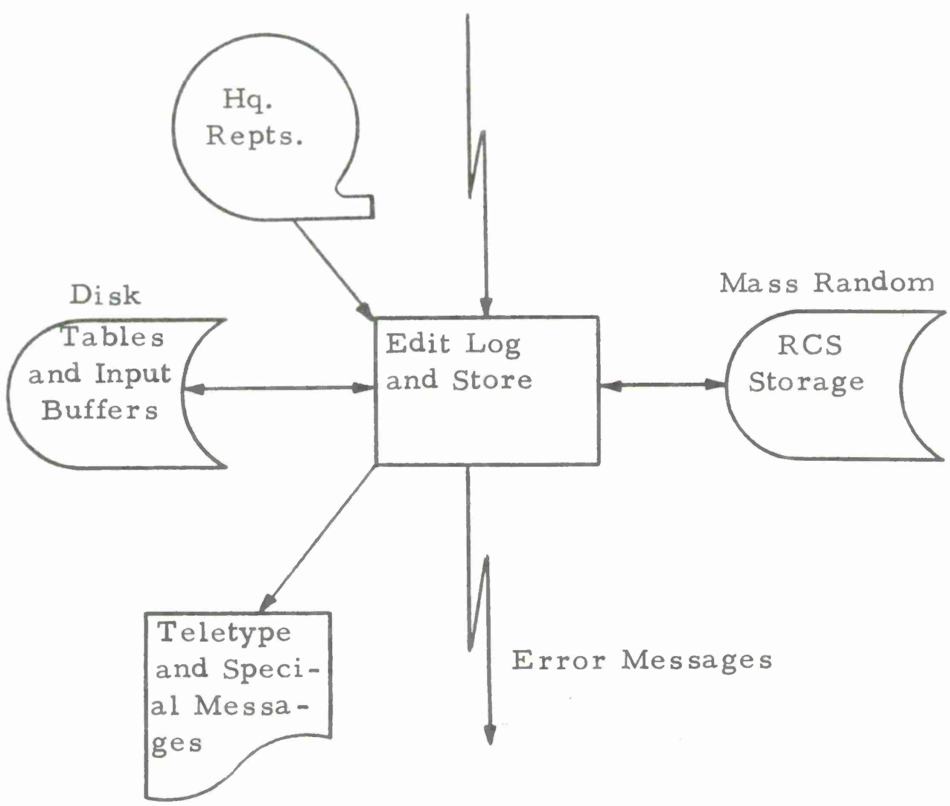


Figure 6: PROPOSED SYSTEM - PROCESSING OF INCOMING TRAFFIC

A. Incoming Messages (continued)

1. Format Editing: See list of header and trailer format edits in the Appendix. In addition to those edits, each detail record will be checked to determine if the Command Code is in the column(s) specified for the RCS entry in the Text Header and Text Trailer. The detail record Command Code will also be compared to the Command Code in the Text Header. These two edits will insure that the detail records apply to the proper RCS and Command.

2. Error Message Generation: Detection of critical format errors will cause a system-generated error message to be automatically formatted and stored on the disks for transmission. Under normal operating conditions, this error message will be transmitted almost immediately.

3. Message Logging and Statistics: All incoming messages will be logged in essentially the same format used in the present system. This log will be listed on the line printer daily. The operational "log" will consist of a series of tables for each RCS listing every reporting Command for that RCS. A more detailed "log" will consist of a separate table for each reporting Command under each RCS. This detailed table will list every message transmitted. The real-time logging of incoming RCS's will provide the inquiry terminals with the accurate, up-to-date data necessary to efficiently schedule data edits and report production. These tables will also provide the necessary data to generate periodic traffic statistics by RCS.

4. Message Storage: RCS messages will be stored on a mass random access device within seconds after they are received. At this point, a message is available for random access retrieval on command from the AUTODIN Command and Query Terminal (ACQT).

5. Automatic Alert Generation: Although the ACQT operator will be able to set a series of alerts relating to incoming traffic, there is a need for a series of system-generated alerts based on RCS status at the time of message receipt. When a message is received for an RCS that has already been dumped to tape for data editing and report production, an alert will be transmitted to the ACQT (CRT and hard copy) indicating whether the message is a Resubmission or a duplicate. The message will be stored in the Suspense File section of the mass random device. If the operator is advised that the message is needed, he can use the ACQT to dump it to tape.

5. Automatic Alert Generation (Continued)

When a message is received that is a duplicate of a message already stored on the mass random device, an alert will be generated, including the headers and trailers of the duplicate message.

6. Printing of Selected Messages: The system will print all teletype messages on the line printer. Any Single Card (SC) format message that is not a negative RCS report will also be printed. In addition to these system-generated printouts, the ACQT operator may print out any message that is stored on the mass random device.

B. Terminal Functions

This section enumerates the various query and control terminal users. Certain of these are special requests that can only be executed by the Command terminal; these are system maintenance operations and functions requiring machine operator scheduling, and are marked with an asterisk (*) in the following discussion.

Hard copy will be available of any CRT display upon user request, some immediately via the console typewriter, and others, necessarily of lower priority, via the system line printer.

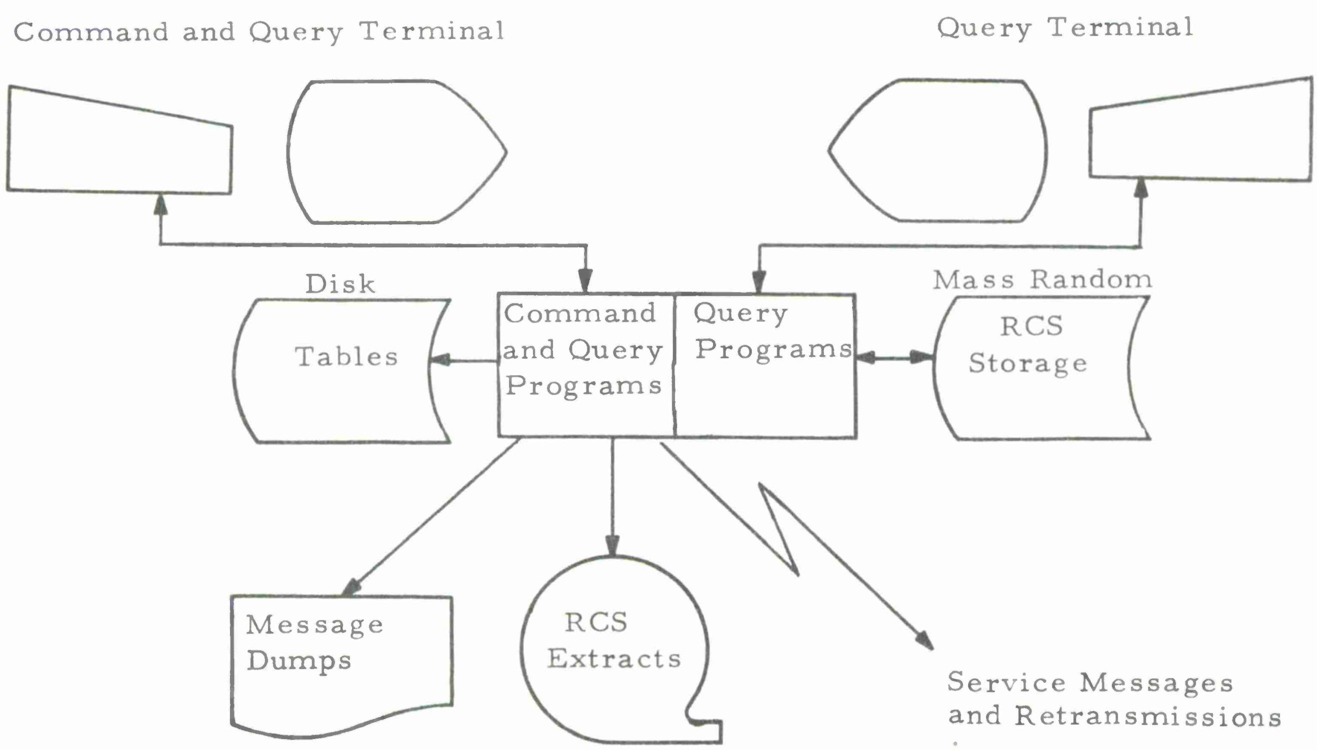


Figure 7: PROPOSED SYSTEM - TERMINAL FUNCTIONS

Table I: TERMINAL FUNCTIONS

Function Type	Function #	Function Name	Approximate Response Time	Remarks
RCS STATUS	1	Total System Summary	10 Minutes	A CRT display showing the number of RCS's complete, incomplete and complete but awaiting messages
	2	Total System Report	10 Minutes	Function #1 plus a detailed report on the line printer showing the status of each RCS by reporting Commands.
	3	RCS Status	10 Seconds	Status report for a designated RCS. It will show status and message counts for each reporting Command.
	4	RCS Status by Command	5 Seconds	Selected RCS and specified Command Status, message count and missing message numbers.
ALERTS *	1	RCS Alert	5 Seconds	Report upon completion of all reporting Commands for one RCS or upon individual Command completion.
	2	RCS Command Alert	5 Seconds	Report is generated each time a message arrives for the specified Command of the selected RCS.
	3	RCS Command Message Alert	5 Seconds	Report when a specified message is received.

* These functions apply only to the Command Terminal.

Table I: TERMINAL FUNCTIONS (Continued)

Function Type	Function #	Function Name	Approximate Response Time	Remarks
FILE EXTRACTS *	1	RCS Extract	5-30 Minutes	All reporting Commands of the specified RCS are dumped to tape.
	2	Command Extract	15 Seconds	The selected Command of the specified RCS is dumped.
	3	Message Extract	5 Seconds	A single message is dumped.
MESSAGE TRANS-MISSION *	1	Service Messages	- - -	Command terminal operator keys-in narrative messages.
	2	Retrans-missions	15 Seconds	Operator calls in message from mass random and keys-in new date-time entries.
FILE AND TABLE MAINTE-NANCE *	1	Table Maintenance	- - -	Command terminal operator will be able to update all core and disk tables.
	2	File Maintenance	- - -	Operator will be able to allocate and deallocate disks and mass random storage.

* These functions apply only to the Command Terminal.

C. Outgoing Messages

The system will operate in full-duplex mode. The bulk of the outgoing traffic will be delivered to the AUTODIN computer operator in magnetic tape format. This tape will be the input to the on-line version of the BILDR Program, as shown in Figure 9. These assembled messages will be stored on a disk and transmitted in order of precedence. When a message has been transmitted, it will then be stored on the mass random access device for one month if there is sufficient storage available. This will enable the ACQT operator to respond to retransmission requests by keying-in the approximate message identification. Provision will be made for overflow of this storage area, i.e., in an overflow condition, the overflow messages will be dumped to magnetic tape storage; in this way, the most recent outgoing traffic that is more likely to require retransmission will be available in random access storage.

Error messages, generated when an incoming message fails an edit routine, will be stored in a core buffer. In addition, since the error messages will tend to be rather short, they will have a transmission priority over the normal outgoing traffic.

Service messages may be entered into the regular stream of outgoing messages on magnetic tape, or they may be "keyed-in" by the ACQT operator.

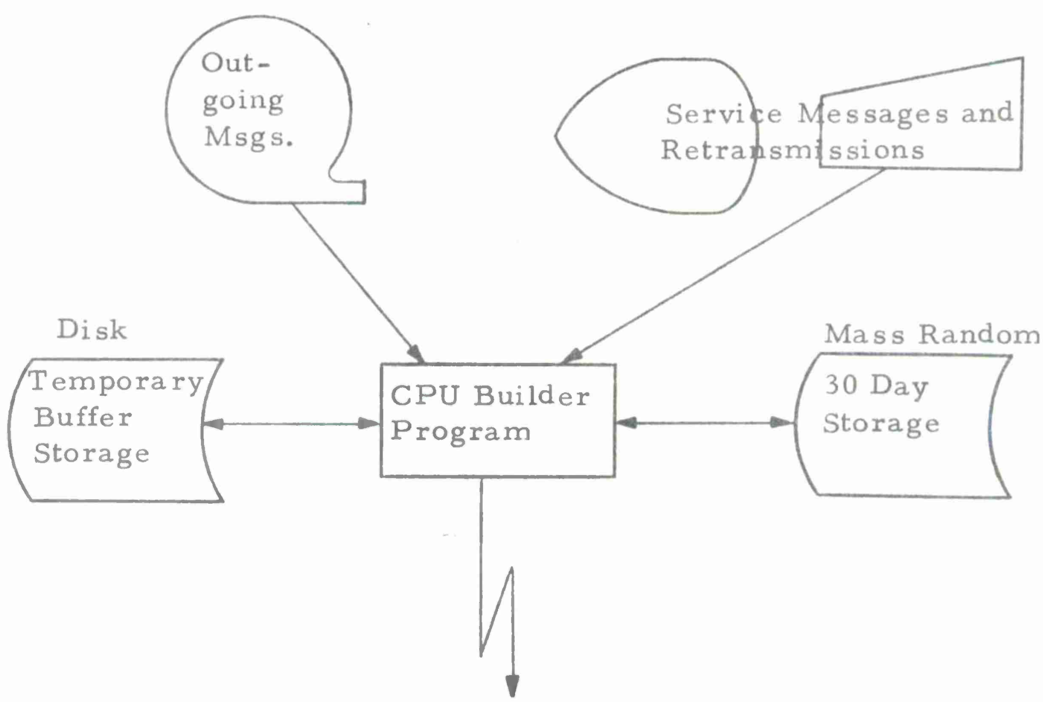


Figure 8: PROPOSED SYSTEM - PROCESSING OF OUTGOING TRAFFIC

D. Program Maintenance and System Statistics

1. Maintenance: Due to the dynamic nature of RCS reporting requirements, the AUTODIN control system must be flexible enough to adapt to changing needs. The system must be capable of handling additional RCS's, dropping RCS's, adding new reporting Commands to existing RCS's, as well as the many permutations of additions, deletions and modifications.

   In order to facilitate these changes, a number of system maintenance functions will be available to the ACQT. Without taking the system off line, the operator will be able to reconfigure, modify and expand the system's capability. Only in limited circumcumstances will the system be required to shut down for software system maintenances.

   The maintenance function will include the necessary modules to provide periodic dumping of critical files and tables to magnetic tape for backup in case of file destruction.

2. Statistics: The AUTODIN control system will provide detailed statistics covering both normal operations and system performance.

   The operations statistics will consist of reports concerning the activity of the system over a previous pre-set period. It will include such information as incoming message counts, outgoing message counts, error totals by RCS and/or Commands, and record totals, by Command and RCS.

   The system performance statistics will be used by the group responsible for system maintenance. They will contain such information as table size, mass random allocations, overflow conditions and file activity. By use of these reports and the system maintenance functions, the AUTODIN control system can be reconfigured to increase efficiency and reliability.

E. System Recovery Procedures

In order to permit the system to continue operation in a degraded mode, due to equipment malfunction, a set of backup procedures will be developed. This graceful degradation process will permit continuation of those functions which are independent of down devices. Upon restoration of down devices, the system will recover lost functions. Devices will be declared "down" by the operator or the software system.

E. System Recovery Procedures (Continued)

1. Communications Lines Procedures:

   a. Inline - none

   b. Outline - no transmission of messages. Error messages from Inline will be stored on disk.

2. Mass Random Procedures:

   a. No incoming traffic will be stored. A tape will be used as a buffer till the device is repaired. If a tape is not available, the switching center will be requested to stop sending.

   b. No tape dumps are possible.

3. Disk Procedures: Disk #1 is dedicated to operating system residence; therefore, Disk #1 must always be available. If it malfunctions, Disk #2 will assume systems residence. In this mode, input traffic will be put on to tape. No outgoing traffic or query capability will be possible.

4. Tape Procedures: Tape #1 and Tape #2 will alternate in function. If one tape is down, only one of the dump or tape transmission functions will be allowed.

5. CRT Procedures: Limited query and dumping functions will be permitted by use of the card reader and printer.

F. Operating System and Software Utilization

1. Communications Lines: The manufacturer will provide, in addition to the AUTODIN buffer hardware, a set of software to interface with the pseudo communications language to be developed in Phase 2. The pseudo communications language will be a set of I/O calls to the communications line handlers permitting reading, writing, and line control. Error control will be handled by the hardware and manufacturer's software. The pseudo language will permit detail system design without actual communications software. The pseudo language will be general enough to permit modifications, tailoring it to the hardware without excess design modifications.

F. Operating System and Software Utilization (Continued)

2. Random Access: The manufacturers will provide a set of handlers for each type of random access device specified. They will be capable of operating in either sequential or random modes.

3. Card Devices: The manufacturers will provide a set of card device handlers.

4. Tape Devices: The manufacturers will provide a set of magnetic tape device handlers.

5. Real-Time Clock: The software will be provided to permit access to the real-time clock for both time stamping and interrupt action.

6. Multi-Programming: To permit the many asynchronous tasks to operate in the system concurrently, a multi-programming facility is necessary. The manufacturers will provide an operating system with sufficient levels to support the system and at least one background job.

7. Display Terminals: The manufacturers will provide a set of software to permit full control of the display terminals to include request attention interrupts.

G. System Design Philosophy

In order to design a system which will have to have both machine and software independence, a modularity approach will be taken. The system functions will be broken up into asynchronous modules, and each will be able to run concurrently in a multi-programming environment, dependent only upon its activation criteria and input/output file priority. Additionally, interlocks will be designed into each module to prevent the transmission of erroneous information to other modules. An example of interlock would be to prohibit two modules from making entries into the same Command message table simultaneously. When the actual hardware and its supporting software is known, the modules will be fitted with the operating system to produce the final system.

A standard format will be adopted for module documentation. The documentation will contain:

1. Activation Criteria: The conditions necessary for the module to start execution.

G. System Design Philosophy (Continued)

2. I/O Priority: The priority which the module will have for reference to each file it uses. The priority is determined by the effect of I/O delay upon total system performance.

3. Interlocks: The interlock conditions and the action to be taken upon recognition of such.

4. Common Module Communications Pool Reference: The information that the module must update or check in the common module communications pool.

5. Detail Flow Charts

6. Flow Chart Narrative Descriptions

SECTION IV

CONCLUSIONS

Although the present system encompasses most desirable controls, there are a number of inherent characteristics of the system that severely limit its overall effectiveness.

One of the more effective means of isolating, understanding and solving system difficulties is to trace the flow of a transaction through all facets of the system as a means of exploring the effectiveness of the processing of abnormal as well as normal transactions.

The present AUTODIN terminal accepts messages and stores them on reels of magnetic tape that, under normal operating conditions, are removed from the AUTODIN terminal tape drive approximately every eight hours. This input tape is then scheduled for processing by the 1401 LOGER Program. For the sake of example, let us assume that the first message on this tape is a narrative teletype message. That is, a message we "received" eight to twelve hours ago is now, for the first time, about to be subjected to some sort of processing. The teletype message will now be printed on the 1401 printer and be available for some sort of further action based on human decision.

If the originator of this teletype message was concerned about the length of time necessary to transmit the message, he may have assigned a priority precedence code. The priority code would have accelerated the transmission of the message to the AUTODIN terminal but, from that point on, the priority designation would have absolutely no value within the framework of the present system. Therefore, an originating station that is truly concerned about the time is forced to use some other means of communications in order to insure considerably earlier action by human intervention. The transmitter, having made such a decision, has exercised good judgment, and has also characterized one of the more critical shortcomings of the present system.

Delays of this type are even more significant if one traces an RCS message under similar circumstances. The RCS message would be subject to the same delays at the magnetic tape terminal. If the message were an "X" or "Y" precedence, it would be printed out by the 1401 LOGER Program. In this case, an RCS message would have reached a point of human action at the same stage of processing as the previously discussed teletype message. The average RCS message, however, would not yet be subjected to human intervention. It would first be subjected to format edits by the LOGER Program, whereby the headers and trailers would be printed out on the log that is used for the manual RCS control process. This log is the

first point at which a regular RCS message can be identified. If this RCS message is one that is necessary to complete a particular RCS, the person transcribing traffic from the 1401 log to the RCS control cards would have been previously alerted to watch for it.

Even the positive identification of the RCS at this point is insufficient, since further manual and machine processing is necessary to make the message available to the Data Application Division staff. In order to accomplish this, the message must next be scheduled for processing by the RITER Program, to extract the message from the magnetic tape that was produced by the LOGER Program. In addition to the delay caused by having to schedule a separate RITER run to extract the message, there is a further delay in the machine processing itself, because the messages are stored on magnetic tape and RITER must read each sequential message on the tape until it finds the one tagged for extracting. If there are several RCS messages that are needed to complete an RCS, and if they arrive many hours apart, they will be on separate AUTODIN terminal tapes and separate LOGER output tapes. This necessitates a separate RITER extract from each of the LOGER tapes in order to collate those messages that are holding up any further processing of the RCS.

It is clear that these inherent delays in the present system are attributable to the batch-sequential mode of processing. If messages could be logged immediately upon receipt and made available for extraction on a direct access basis, it would be possible to complete the processing of an RCS much earlier; perhaps as much as two days could be saved in extreme cases. The true concept of a real-time system is that it should provide as fast a system response as will benefit the application. The potential benefits of real-time logging, inquiry and retrieval are rather evident. A real-time system with a mass random storage device would eliminate all of the scheduling delays that characterize the present system; furthermore, it would provide completely accurate logging, in place of the present manual logs and their attendant clerical errors.

The editing facilities of the present system cause even greater delays than those due to message logging. Selected format edits are now performed by the LOGER Program, and message headers and trailers are visually scanned during the manual RCS logging procedure, but many other possible format checks are not part of either procedure. The present system performs rudimentary format edits on the AUTODIN and text headers and trailers, but does not determine whether the data records that constitute the message are for the RCS and Command specified by the headers and trailers. Thus, it is possible for a message to be completely processed and delivered to the 7080 for data edits and report production without knowing whether the message is what it purports to be. Such errors are finally discovered when the 7080 data edit program hangs up; but, by that time it may be several days since the message was originally

received on the AUTODIN terminal. The Command Code in the header and trailer is neither validated nor compared with the Command Code in the data records. When such errors are discovered, it usually requires the transmission of a message to the originator to resolve the error. Thus, the cycle of system delays begins all over again. If the message was late in the first place and was holding up final report production, it is possible that the total delay can be doubled or tripled.

Some of the header and trailer edits that are presently performed are rather limited in value; even though a message can pass the edits, at some further point during the processing cycle it may nonetheless be necessary to transmit an error message to the originator. An example of this type of inadequate format edit is that performed on the RCS number. The present system merely checks for the presence of an entry in the RCS field, but it does not validate the entry. Therefore, it is possible for an illogical RCS number to enter the system and go undiscovered for some time. When it is finally discovered, it may require the transmission of an error message. If so, the cycle of delay is triggered again.

The solution to these recurring delays lies in the design of a real-time edit routine and error message generator. The format edit routine must conclusively establish the validity of the message as it is represented by both the AUTODIN and Text headers and trailers. Whenever feasible, field entries should be subjected to absolute validation by table look-up procedures, rather than just checking for the presence of an entry. This is particularly true of the RCS numbers and the Command Codes. It is desirable and feasible to perform these edits during receipt of the message. Then, if the message has not passed the format edits, the system can immediately generate an error message to the transmitting Command.

Operation of the new system in full duplex mode will permit the system to transmit the error message as soon as the message currently being sent is completed, rather than to wait until the current batch of outgoing messages is completed, as is the case with the present system.

The inquiry and control aspects of the present manual RCS control system are germain to our analysis. (Scheduling batches of messages for data editing and report production on the 7080) The process consists of a series of verbal inquiries that are answered by looking up the record of received and missing messages for the RCS in question. If there are missing messages, and if the report is overdue, it is necessary to use TWX or telephone to contact the reporting Command. The heavy demands upon the people who maintain this manual file are such that it is virtually impossible for them to keep the Data Applications Division staff fully informed regarding RCS status. (Even when missing messages are manually logged, it is still necessary to schedule them for extracting by the RITER

Program.) These two critical functions of RCS status inquiry and the control function of extracting a message or contacting the reporting Command to request transmission are also logical candidates for inclusion in the real-time system concept.

When the accumulation of RCS messages has reached the point where only a few more messages are needed to complete the RCS, it is essential that the system be capable of automatically recognizing RCS completion so that there will be no delay in extracting the data for further processing. The control tables which the system will use to log incoming messages will also serve to answer status queries and will provide a vehicle for the Command terminal operator to set "alerts" for a particular message or RCS or Command. Once the operator has set the alert flag, it will be unnecessary for him to further query the system; rather, the system will now automatically alert him, via CRT and a printed message, that the designated message has arrived. The operator will then have the Command ability to direct the system to extract that RCS for further processing on the 7080. Thus, real-time Command and control capability will enable the system to begin extracting an RCS within seconds or minutes after completion, as opposed to the present potential systems delay of many hours.

Because of the half-duplex operation of the present system, the sending of delinquency messages requesting a Command to transmit messages that are missing from an RCS is of little value. It is necessary to write the message on a magnetic tape, whereupon the tape is subject to terminal delays until a group of incoming messages has been received, before the terminal can be used to transmit. Operation of the new system in full-duplex mode, with the ability to accept keyed-in messages from the Command terminal for immediate transmission, will provide the speed necessary to justify its use for such operational messages. The system will be capable of formatting and transmitting error messages, delinquency messages and other service messages keyed-in by the Command terminal operator at the same time it is performing these functions for the normal stream of outgoing traffic. Random access capability will enable the system to more readily insert priority outgoing messages at the head of the message stream.

In summary, application of the "real-time" concept to the AUTODIN System implies the capacity to perform the necessary edit, logging, storage and inquiry and Command functions within a time-frame that will provide the optimum effective benefits to the system users.

Format edits must be performed at the earliest point possible in the data flow to permit early transmission of the error message. The second advantage of performing all format edits at the instant of message receipt is that the system is relieved of the wasteful function of further processing a message that must ultimately be rejected by the system.

The input message logging function must immediately follow the edit routines if it is to adequately support the inquiry capability of the system. Any substantial delay between message validation and message logging would present an inaccurate status report that would tend to degrade the effectiveness of the inquiry system.

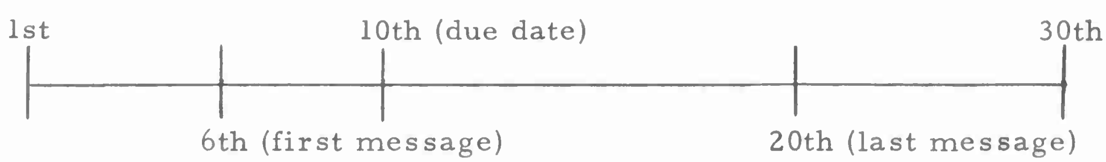
Storage of incoming and outgoing traffic should provide the ability to extract either a single message or a group of messages without the necessity of reading through groups of unwanted messages. The tables that serve the logging function can perform a three-fold function in that they can log the message, answer status inquiries and provide the addresses of specified messages that are to be extracted.

Maintenance of a master file for the storage of this traffic has necessitated the analysis and comparison of various types of random access systems. In this regard, there are two major system requirements to be considered:

1. Workload: Although the RCS and other traffic volumes may fluctuate sharply in either direction, it must be assumed that the potential exists for a substantial increase in traffic. The master file storage requirement for all incoming and outgoing traffic has been established at 272, 000, 000 characters per month. This storage requirement includes the accommodation of peak traffic for quarterly, semi-annual and annual reports.

2. Message Retention Period: The length of time that a reporting Command's RCS must be maintained on the master file has a direct effect on the total storage requirement. The period of retention is, in turn, directly affected by patterns of message receipt and efficient extracting of messages for data edits on the 7080.

The most common pattern of message receipt is that the first transmissions are received at least three or four days prior to the due date, and the final transmissions are received approximately eight to ten days after the due date, e. g.,



The normal pattern, therefore, accounts for at least 50% of the reporting period. Any substantial deviation toward earlier and/or later reporting during a peak period could seriously inflate this basic retention period.

Messages are now extracted for data editing in blocks of 100,000 records. It is desirable to maintain this size in order to keep 7080 set-up time at a minimum. However, it should be noted that the longer the records must be maintained in the master file until the block is complete, the more storage capacity is needed.

Alternatively, if we were to assume that all factors tending to reduce the storage requirement actually decreased it by 20%, i.e., to approximately 218,000,000 characters, it would be possible to consider the group of random access devices that provide approximately half the storage of the mass random (magnetic card or strip) devices. However, the cost of these devices is approximately double the cost of the mass random devices.

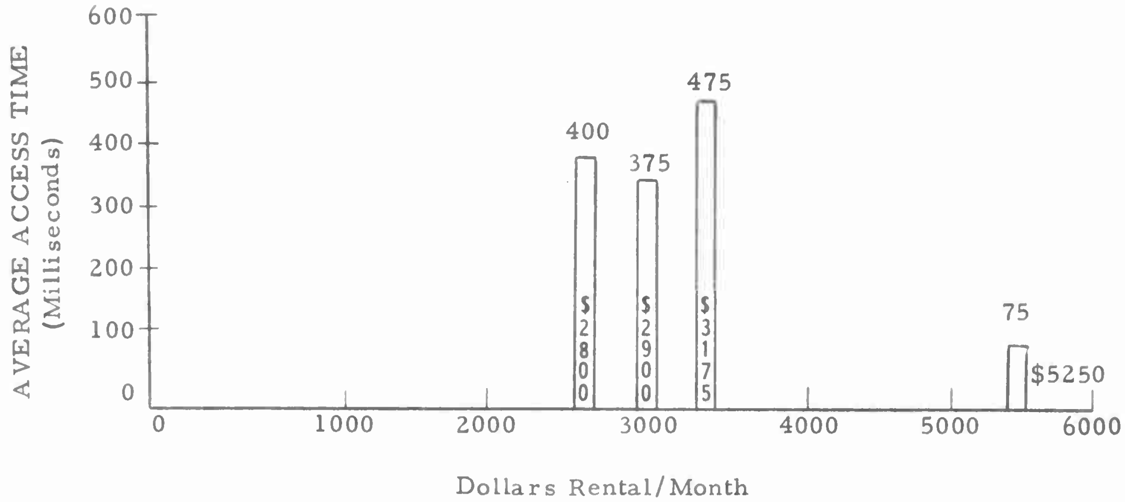
Inasmuch as the mass random devices meet the capacity and cost tests, the only remaining considerations are the adequacy of seek time and read/write time.

The limiting time factor in the receipt and transmission of messages is the 2400 baud line (240 character/second). Using peak transfer time, it will take 2.76 minutes to send and receive a message. If we assume that the system has just simultaneously received and transmitted two 40,000 character messages and the peak demand for the mass random device has now begun -

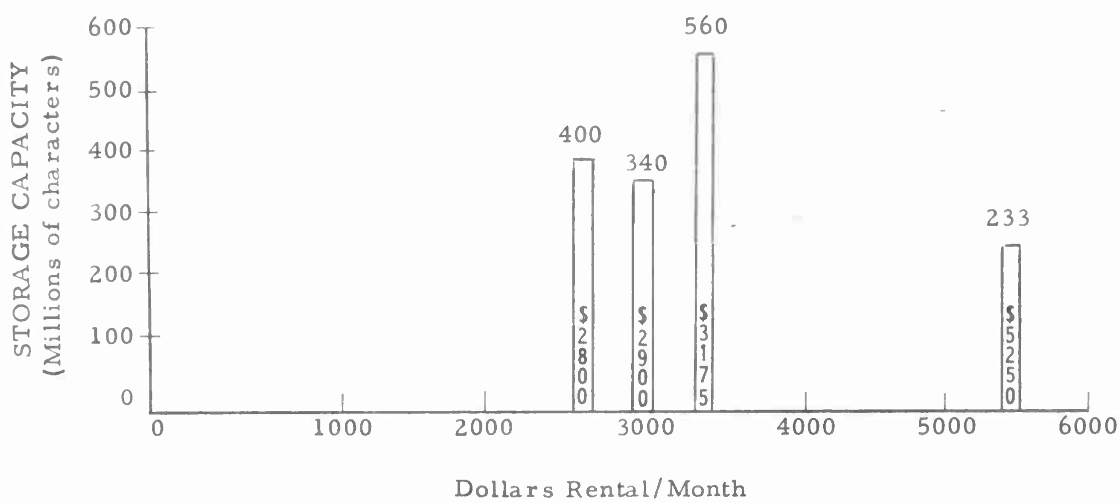
	Transfer	Max. Seek
1. Move incoming message from disk to to mass random	800 ms.	600 ms.
2. Move outgoing message from disk to to mass random	800 ms.	600 ms.
Total mass random time = 2800 ms.	1600 ms.	1200 ms.

It is evident that the mass random device seek and read/write times are adequate to permit real-time operations. That is, the mass random time requirement is less than 2% of the time it takes to receive or transmit a message. The remaining time available on the mass random device could be used to dump messages to tape for external processing. The cost/performance characteristics of several typical equipments are shown in Figure 6.

AVERAGE ACCESS TIME VS. COST



STORAGE CAPACITY VS. COST



TRANSFER RATE VS. COST

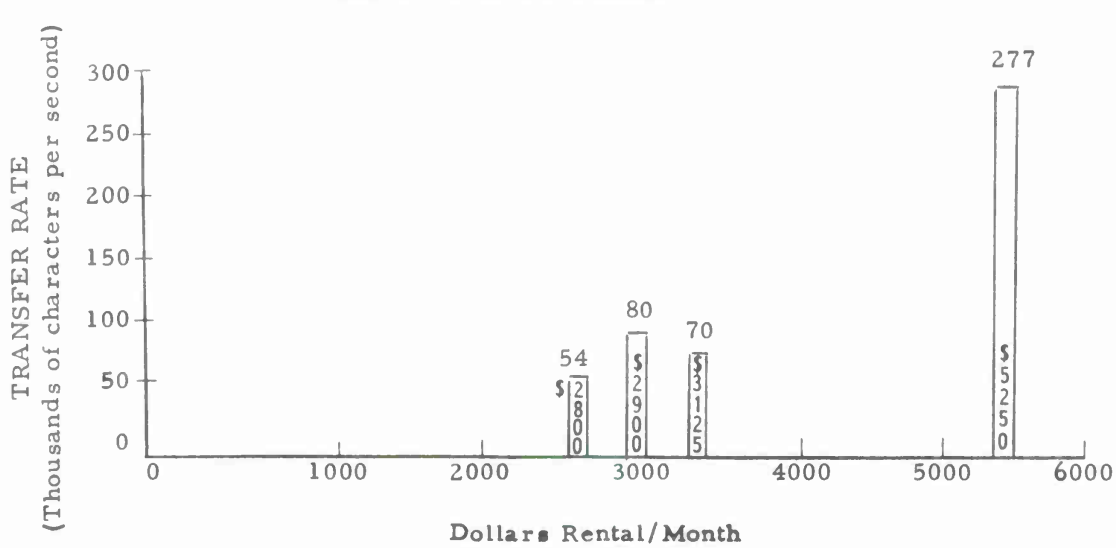


Figure 9: COST PERFORMANCE CHARACTERISTICS

APPENDIX I

INTERNAL SYSTEM MESSAGE HEADERS

Each message that is stored on the mass random device will include an internal system message header. The header length is 400 characters long, containing an 80-character summary and a copy of each of the AUTODIN and text headers and trailers. The internal message header will be used by the log and store module to correctly catalog each message. Further, it will be used to aid in reconstruction of the system tables in case of Disk destruction.

Position	Char	Meaning
1	R	Store RCS File
	K	Store Reject
	T	Store Teletype File
2 - 5	Binary	Message Length Logical Records Including Header
6	T	Classification
	S	
	C	
	U	
7	C	LMF-CC
	S	LMF-SC
	D	LMF-DD
	B	LMF-BB
	I	LMF-II
8 - 14		Call Sign of Originator
15 - 18		Station Serial Number
19 - 21		Julian Date
22 - 25		Time Filed
26 - 29	Binary	Text Message Record Count
30	Blank	No Text Header
	"X"	Text Header Present
31 - 44		RCS Number
45 - 48		Record Length
49 - 50		Blocking Factor of Original Message
51	R	Resubmission
	S	SUS/DUP
	B	Both
52 - 55	Binary	Received MSG Number This Station (Cross from Log)
56 - 58		Message Number
59 - 64		As of Date YYMMDD
65		Command Code
66 - 67		Error Message Codes

Figure 10 (a): INTERNAL SYSTEM MESSAGE HEADERS

```
R0034SCRUEBAAA004514401000496X6AFP6*2       008001 0001001670401A
                AUTODIN HEADER
                   TEXT HEADER
                                     TEXT TRAILER IF PRESENT
                                       AUTODIN TRAILER
```

Figure 10 (b): INTERNAL SYSTEM MESSAGE HEADERS (Concluded)

APPENDIX II

TABLES

Mass Random and Disk Storage Formats

In order to design the portions of the system which require random access ability in such a way as to provide hardware independence, a logical Storage System was developed. Files, such as logs, which require sequential processing will not be allocated within the logical Storage System. This logical storage scheme will be used on both the mass random and the disk devices.

The file space made available for message storage on the mass random device, and for tables and buffers on the disks, will be organized into fixed-length blocks. Each block will have a logical record number, starting from 1. The equipment manufacturer will provide an algorithm by which the logical record number can be converted to a physical device address. The data portion of each logical record will be 1200 characters; additional characters can be added to provide error (i. e., bad track) sentinels.

Table Organization

Access to a message stored on the mass random device is provided through a hierarchy of tables. These tables are in core and on the disks. By having the tables reside on disk, the status information is available without access to the slower mass random device.

A. RCS Core Table

The RCS Core Table is the first table used in the storage and retrieval of any system information. It is a list of all the current RCS's recognized by the system, with the "as of date". Associated with each RCS "as of date" entry is a logical record number pointing to the RCS Command Table location on the disk. There is a counter for this table indicating the number of current active RCS's in the table.

A1. Command Validation Table

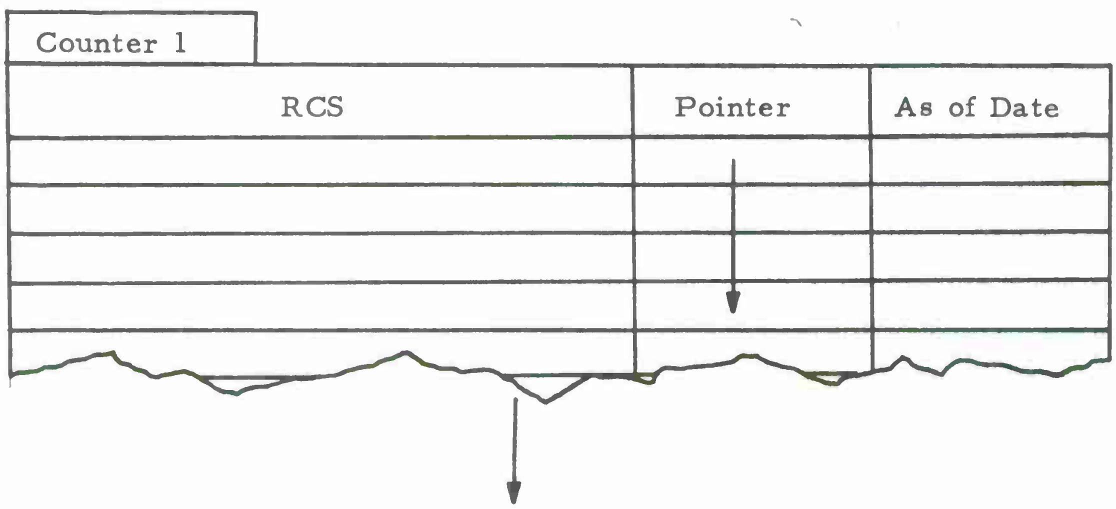
B. RCS Command Table

For each active RCS, there is a Command Table. This is a list of all the reporting Commands for that RCS. Each Command has a pointer which identifies the RCS Command Message Table for that Command.

C. RCS Command Message Table (Disk)

For each reporting Command of each RCS, there is an RCS Command Message Table. This table is the equivalent to the RCS index cards in the Manual System. It is in this table that a pointer exists to the location of a message on mass random. There is a space for each message number expected from that Command. (Provision exists for overflow conditions.) The message number entry is located by displacement in the table.

Example: Figure 14 illustrates the method used in retrieving AF010's fifth message from SAC.



Counter: 4 Characters (32 Binary Bits) - Binary
A binary number representing the number of active entries in the table.

RCS: 14 Characters - BCD
The RCS symbol left justified.

Pointer: 4 Characters - Binary
A binary number indicating the logical record number of the RCS Command Table.

As of Date: 6 Characters - BCD
YYMMDD

YY	=	Year
MM	=	Month
DD	=	Day

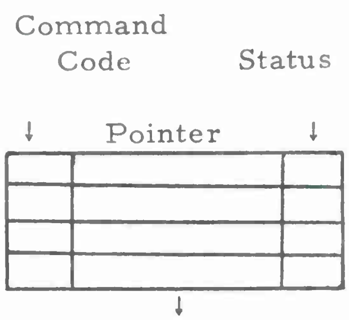
Figure 11: RCS CORE TABLE

SYSTEM PARAMETER

ACTIVE ENTRIES

ALERT

OUTPUT BLOCKING



System Parameters:	9 Characters Software parameters to be used for dynamic table allocation, and multiple-logical record tables.
Active Entries:	4 Characters - Binary A binary number indicating the number of entries in this table.
Alert:	1 Character - BCD A flag used to indicate issue of alert reports upon changes to any status entry.
Output Blocking Factor:	2 Characters - Binary The standard output factor to be used in tape dump.
Command Code:	1 Character - BCD The 1-character Command Code of each reporting Command.
Pointer:	4 Characters - Binary A binary pointer to the logical record containing the RCS Command Message Table.
Status:	1 Character - BCD An indicator as to the status of each reporting Command.

Figure 12: RCS COMMAND TABLE (DISK)

SYSTEM PARAMETERS

STORAGE

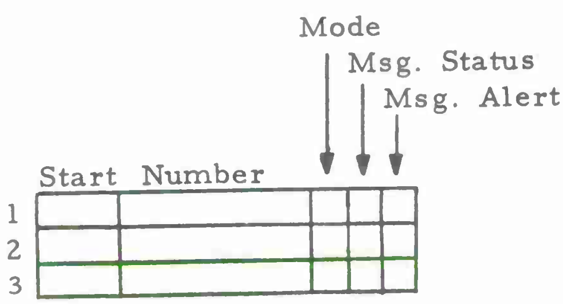
High Message Number

Total Messages Received

Number Messages in Complete Report

RCS - Command Alert Flag

Status



System Parameters:	9 Characters	
Storage:	4 Characters A pointer to a table used by the system to allocate mass random storage for a message.	
High Message Number:	3 Characters - BCD The highest message number received at this time.	
Number Messages in Complete Report:	3 Characters - BCD Message number of text trailer received.	
RCS - Command Alert:	1 Character - BCD Signal to issue alert report upon change of status or reception of any message for this RCS Command.	
Status:	1 Character - BCD Status of Reporting Command	

Figure 13: RCS COMMAND MESSAGE TABLE

Start:	4 Characters - Binary Logical record number of first record of message on mass random.
Number:	4 Characters - Binary Number of logical records used to store message.
Mode:	1 Character - BCD The LMF mode of message.
Message Status:	1 Character - BCD Status of message (not received, received, dumped, etc.)
Message Alert:	1 Character - BCD Request to issue alert report upon receipt of message.

Figure 13: RCS COMMAND MESSAGE TABLE (Concluded)

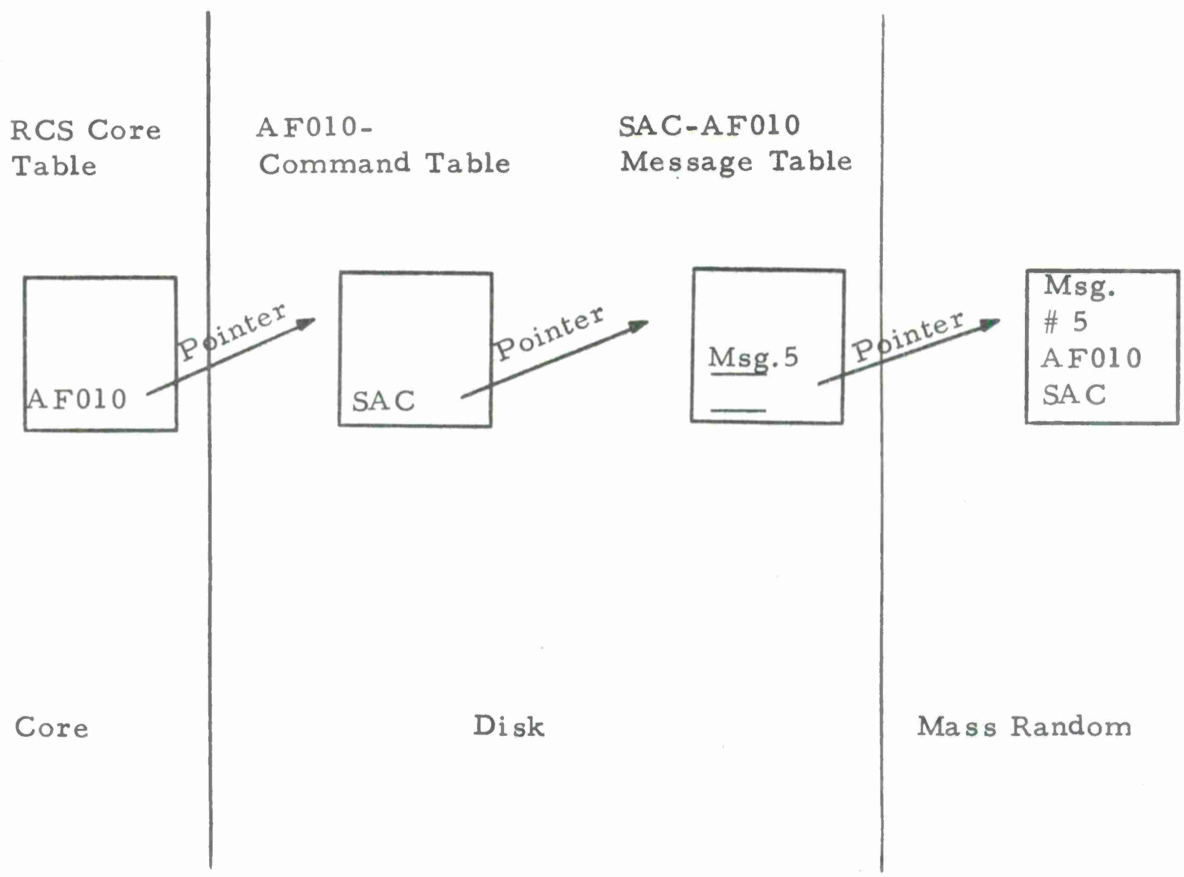


Figure 14: TABLE FLOW

APPENDIX III

FORMAT EDITS

Card Columns	Field Description	Edit Procedure
AUTODIN Header		
39 - 40	Start of Routing Signal	--identifies the AUTODIN header.
1	Precedence	"X" or "Y" entries will cause this message to be printed on the line printer.
2 - 3	Language Media Format	If CC3 is "T", print the message and abort text edit routines. If entry is "SC", branch to Single Card edit routine.
30 - 33	Record Count	Store for later validation.
Text Header		
1 - 6	Text Header Identification	Must contain "TEXHDR"
8 - 21	RCS Number	If there is an entry, it must pass TLU.
24 - 29	As of Date	Must pass the TLU edit with the RCS Number.
32	Resubmissions	If entry is "R", bypass duplicate test. If original message has been extracted for report processing, flash an alert to ACQT.
42 - 44	Message Number	Test for numerics. Test for equal or less than final message number.

FORMAT EDITS

Card Columns	Field Description	Edit Procedure
Text Header (Continued)		
46 - 49	Record Length	Store and compare against data records.
71 - 77	TO/FROM	From field must equal data record Command Code if CC 78-80 are blank.
78 - 80	Command Being Serviced	If there is an entry, it must equal the Command Code in data records and pass the RCS-Command TLU.
Text Trailer		
1 - 6	Text Trailer Identification	Must contain "TEXTLR".
7 - 45	Duplicate of header fields	Must compare.
49 - 51	Total Number of Messages	Used by query program to identify missing message number.
AUTODIN Trailer		
1 - 38	Duplicate of Header	All fields except record count must be equal. Record Count (CC 30-33) may be "MTMS" in header and have a valid entry in the trailer.

APPENDIX IV

RCS DATA

Monthly RCS's

	RCS Number	No. of Commands	Location of CMD. Code	Total Record Count (All Commands)
1	HAFA1	1	2-4	6,000
	HAFXDDC39	8	70	1,559
	HAFC42	13	4	2,535
6	HAFE6	22	3-4	12,027
8	HAFE6	22	3-4	12,356
2	HAFM18	17	4	7,966
	HAFM22	16	77	68,357
	HAFM26	17	4	16,657
	HAFO10A	23	2	530,316
	HAFO10D	19	2	3,347
	HAFO18	1	1	2,500
3	HAFP2	20	1-3	10,867
	HAFP212	17	1	?
1	HAFQ2	22	2-4	24,972
4	HAFQ2	22	2-4	3,126
	HAFXCSQ16	16	2-4	417
1	HAFS11	14	29	6,314
5	HAFS11	13	7	8,627
	HAFY20	2	20-22	11,000
1	HAFZ28	15	11	1,391
2	HAFZ28	18	11	2,481
	Monthly Totals	318		732,815

APPENDIX IV (Continued)

RCS DATA

Quarterly RCS's

RCS Number	No. of Commands	Location of CMD. Code	Total Record Count (All Commands)
HAFC28	22	7-8	17,055
HAFC169	16	4	5,231
4 HAFE6	22	2-3	17,713
JCS1026	17	80	6,842
HAFK14	17	9	79,870
3 HAFM18	16	4	5,030
HAFO10B	8	2	109,511
HAFO10C	22	2	18,804
HAFP32	16	1-3	2,319
HAFP194	17	1	?
2 HAFQ2	21	1-3	6,007
DDI & LQ612	1	2-4	17,600
Quarterly Totals	195		285,982

Semi-Annual RCS's

RCS Number	No. of Commands	Location of CMD. Code	Total Record Count (All Commands)
Wartime Req. Rept.	23	2	?
11 HAFE6	22	4-5	1,030
HAFO13	23	1	183,449
HAFP3	20	?	61,900
HAFP124	23	2-4	?
HAFQ21	21	1-3	61,703
HAFS105	16	15	3,181
1 HAFZ17	19	1	459,780
4 HAFZ17	18	1	174,230
Semi-Annual Totals	185		945,273

APPENDIX IV (Continued)

RCS DATA

Annual RCS's

HAFXDDJ9	21	4-6	16,544
HAFC28	22	7-8	15,218
HAFC128172	18	76-77	21,097
HAFC39D	23	1-3	7,200
HAFXCSQ17	21	3-4	14,952
1 DDCOMPA594	21	1-3	17,441
Annual Totals	126		92,452
GRAND TOTALS	824		2,056,522

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) COMRESS, Inc. 2120 Bladensburg Road, N.E. Washington, D.C. 20018	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP N/A

3. REPORT TITLE

PROPOSED SYSTEM CONCEPT FOR REAL-TIME PROCESSING OF AUTODIN MESSAGES

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

5. AUTHOR(S) (First name, middle initial, last name)

None

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
May 1967	38	0

8a. CONTRACT OR GRANT NO. AF 19(628)-67-C-0259 b. PROJECT NO. c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) ESD-TR-67-294 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)

10. DISTRIBUTION STATEMENT

This document has been approved for public release and sale; its distribution is unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY Computer Directorate, Electronic Systems Division, Air Force Systems Division, USAF, L. G. Hanscom Field, Bedford, Mass. 01730

13. ABSTRACT

This report is the proposed system concept for the real-time processing of AUTODIN messages at the Data Services Center, HQ USAF. The description of the present system emphasizes the batch processing nature of the present computer programs, and their interrelationships with each other and with the manual RCS control system. (U)

The problems that characterize the present system are principally those of the time that elapses between receipt of a message on the AUTODIN terminal and the identification of errors that invalidate the message and require further contact with the originator. The manual RCS control file was identified as being one of the major elements of this time lapse because of the periodic manual transcription of incoming messages to handwritten control cards. (U)

The proposed system emphasizes the desirability of performing data edits immediately upon receipt of each message and the instantaneous transmission of an error message to the originator when the incoming message has failed a format edit. The real-time concept is also the main element of management control through the Command and Query Terminal that provides on-line management decision-making ability without sacrificing any of the advantages of the computer-controlled real-time system. (U)

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
AUTODIN						
Conversational mode						
Information Storage and Retrieval						
Message Processing						
Message Storage						
On-line						
Real-time						
Query						